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Development in Web-based Laboratory Sessions

Bruno Andò[(1)], Pietro Giannone[(1)], Emilio Pecora[(2)] and Nicola Pitrone[(1)]
[(1)]Università degli studi di Catania, DIEES, Viale A. Doria 6
95125, Catania ITALY – tel:+390957382309 – email: bruno.ando@diees.unict.it
[(2)]Istituto Nazionale di Geofisica e Vulcanologia, Sez. di CATANIA-ITALY Phone: +39-095-448084

Abstract *– The laboratory experiments can help the undergraduate students to gain a better understanding the theoretical problem. This paper proposes an educational tool made up a user-friendly interface controlling experimental boards and instrumentation device with a new approach based on FieldPoint™ module and the web publishing tool of the LabVIEW. The proposed system allows students to improve their knowledge in the field of optical sensing devices, virtual instrumentation, data acquisition systems, and signal processing.*

Keywords *– Laboratory session, distance learning, remote driven instruments.*

I. INTRODUCTION

The practical training of the undergraduate students has received great attention in the last years and special sessions are dedicated to the education and training in instrumentation and measurements during some Conferences, because the continuous development of the technologies improves the features of the instruments and dramatically changes the way of teaching electronic measurements; indeed, special didactic sessions emphasize the need of updating the programs as well as adopting useful electronic tools.

Running simulation software can be the first approach to the experimental training for undergraduate students: as a matter of fact they can test their theoretical knowledge, can perform an useful self-training and can acquire a limited hands-on experience. This initial activity is very important, on account of the large number of students and the short time generally available for a correct training in the few years courses.

It has been widely recognise that the use of advanced instrumentation for carrying out real experiments with real electronic components and circuits, is very important for an accurate training on measurement procedures and measurement system design [1, 2].

Moreover, advanced communication technologies will greatly modify the educational methodologies: indeed, networking can be a key point for measurement education. “When the Internet is used for that purpose, the practical aims can be to publish new results and ideas, to create a new form of “distant participation” in scientific events, to discuss ideas for educational work, to develop a new type of process for mutual co-operation, etc.” [3].

Due to growing classes, reduced availability of tutors and shortage of time to be devoted to experimental activities, there is a need of finding a mandatory way of performing laboratory sessions for obtaining a correct practical training of the students. Currently used web-based laboratory training on electrical measurement systems will become more and more important in the future. The internet-laboratory should be integrated in a web-based environment. Of course, it cannot replace a hands-on contact to the measurement object and equipment, however it will be the right solution to the problem of preparing students to make reliable measurements close to real life [4].

In previous works the authors proposed several educational tools aimed to enhance the effectiveness of the experimental activity in the laboratory. A first step was accomplished in order to reduce the boring waste of time for writing accurate technical reports; this initial idea was followed by a study on the possibility of controlling remotely connected instruments. The already obtained results encouraged carrying out a step by step work and a new implemented hardware/software tool has been recently presented [5]: it has been designed in order to support some tutorial assistance to the students; moreover, it reduces the loss of time due to rough inconveniences and represents a key point in the topic of realising remote laboratory sessions. In particular, it has been presented a totally PC controlled board, shown in figure 1, which includes circuits that are suitable for a basic experimental training that can be carried out by the undergraduates. In this way the students can improve the knowledge acquired in the short time that they can spend in the laboratory, in a distance learning activity.

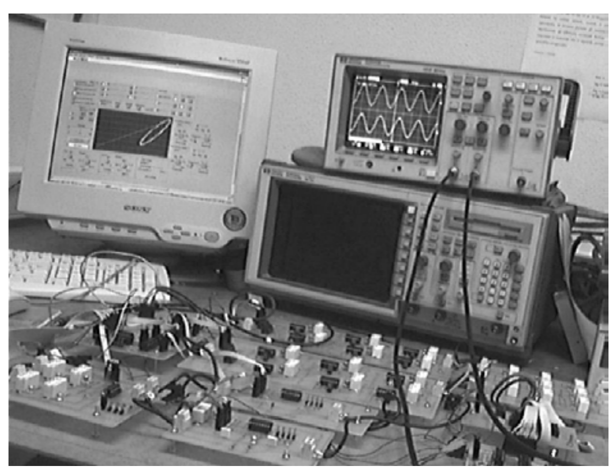

Fig. 1. The old motherboard for the remote measurement

The previously realised tool has been carefully revised, in order to enhance the reliability of the hardware in the lab.

In particular, in this work a field-point controller has been adopted.

Moreover, the values of the components of the circuits that can be analyzed have been carefully chosen, for a more meaningful experimental activity. Additional attention has been paid to improve the features of the implemented software, in order to make it more user friendly.

In the next sections the implemented system is outlined and some examples of its features are presented.

II. THE PROPOSED APPROACH

The block diagram of the developed system is shown in figure 2: it consists of a mother board connected to two function generators and a digital oscilloscope: these instruments are controlled and driven by a dedicated software running on a personal computer.

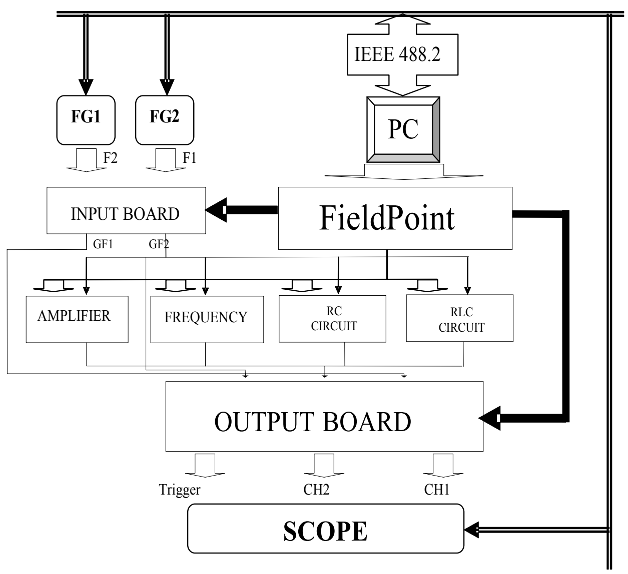

Fig 2. Block diagram of the system.

The mother board, which includes some suitable measuring circuits, is aimed to perform suitable connections between these circuits and the instruments (two function generators and the oscilloscope).

The implemented circuits allow carrying out some usual measurement sessions: on the first-order system (the RC circuit) as well as on the second-order one (the RLC circuit), but also frequency measurements and characterization of an audio-frequency amplifier.

In the last release, there is an evolution of the old motherboard: in fact, the control is now performed by the FieldPoint™, how it is shown in Figure 3: indeed, by adopting the field-point controller a powerful system has been obtained, in spite of the fact that in this applications only some features of this device have been used.

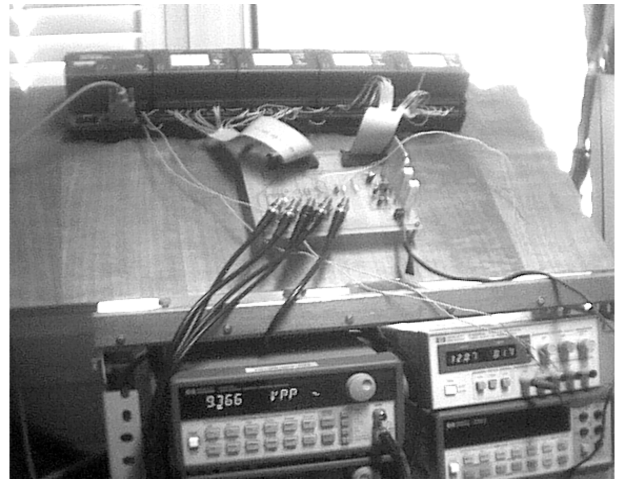

Fig. 3. The new motherboard for the remote measurement with the FieldPoint™

FieldPoint™ is a low-cost, PC-based, distributed I/O system with a variety of communication options ranging from serial to CAN to Ethernet. You can mount FieldPoint™ on DIN rails in static applications where the FieldPoint™ bank is connected to a PC for data collection, analysis, display and storage.

This is an innovative architecture that modularizes communications, I/O functions, and signal termination. Therefore, we can independently choose the industrial network, I/O, and signal termination style that best fit a particular application.

In the application that we consider, the I/O modules, are the Relay Modules. The modules are versatile relay modules that we can use to control signals ranging from low voltages to 125 VDC and to 250 VAC.

The modules feature a maximum switching frequency of 10 Hz (20 operations).

This device allow the communication with the PC by the protocol RS-232.

The selection of the switch that commute the experience selected is carried out by the FieldPoint™ according to the approach adopted explained in the following section.

The control of the instruments is performed via the IEE488.2 standard interface.

The software which has been realized for this work consists of a new virtual instrument, implemented in the LabVIEW™ environment: it enables the student performing the management of the realized hardware, even of there is a far user.

First of all, the user can choose the mode that will characterize the laboratory session, according to the level of the assistance that will be supplied by the expert system: indeed, an automatic mode is available, in which case the experiment will be completely driven by the system; furthermore, a system driven mode can be chosen, in which the user can make some choices; finally, a mode completely driven by the user can be carried out.

Subsequently, the user will select the experiment to be performed, the values of the circuit parameters, the function generator that will be used to force the investigated circuit and the signals that should be sent to the channels of the oscilloscope. At present, only essential pieces of information are supplied to the user, but a more complex educational session has been planned, that will be implemented in the future.

The configuration panel of the software tool is reported in figure 4. As it is shown, the user can act on the dialog box for choosing the experiment to be carried out, the execution mode for the measurement session (driven by the user, guided by an expert system, automatically performed by the software), the circuit configuration (the user can select the values of the passive components of the circuit) and the signal paths. The user can totally control the parameters of the function generators and the configuration of the scope channels.

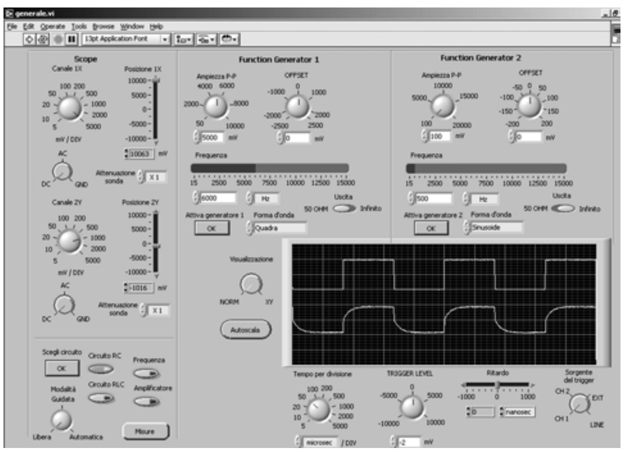

Fig. 4. The user friendly panel of the local control.

III. REMOTE CONNECTION

Considering the increasing number of people using the Internet, the evolution of the described tool has involved the possibility to remote control the laboratory sessions by using the Internet facilities.

When the local instrument for the control of the instrumentation is implemented, the front panel can be remotely viewed and controlled, either from within LabVIEW™ or from within a Web browser, by connecting to the LabVIEW™ built-in Web Server.

In the last version of the educational tool the ID of the client and the server were required, reducing the operability of the educational system [5].

The on-going idea is to use the built-in Web Server facility of LabVIEW, which allows a remote user obtaining the control of the whole system.

Transmission Control Protocol (TCP) is the basic tool for network communication. TCP is responsible for verifying the correct delivery of data from client to server. Data can be lost in the intermediate network. TCP adds support to detect errors or lost data and to trigger retransmission until the data are correctly and completely received.

With TCP/IP you can communicate over single networks or interconnected networks. The individual networks can be separated by large geographical distances. TCP/IP routes data from one network or Internet computer to another. As the TCP/IP is available as the on most computers, it can transfer information between diverse systems.

Actually, the mentioned tool permits publishing the virtual instrument realized to perform the laboratory sessions.

When a front panel is remotely open by a client, the Web Server sends the front panel to the client, but the block diagram and all the subVIs remain on the server computer. We can interact with the front panel in the same way as if the VI were running on the client, except the block diagram executes on the server.

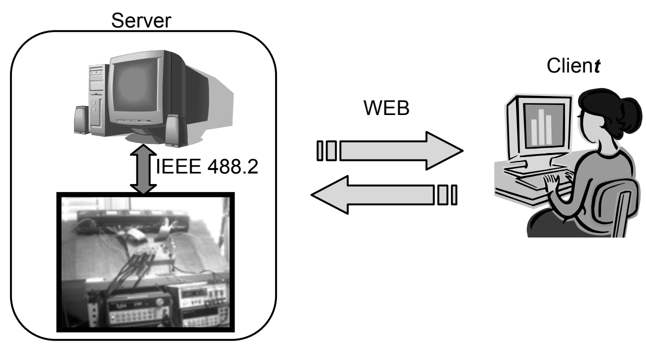

Fig. 5.The scheme using the new tool.

When a virtual instrument has been published, a web page is accessible and the customer can acquire the control of the device by the virtual instrument.

IV. RESULTS

In Figure 6 it is shown the configuration of the panel during the choice of the values of the parameters of the RC circuit. Figure 7 presents just one example of using a webcam. Indeed, an attempt has been made to the use of the webcam. In this way the far user can look at the instrumentation that he is using in the lab, and can verify the effects of the performed choices.

Taking into account the advanced features of the LabVIEW™ environment, an attempt has been made to adopt a local network in view of a next future internet laboratory. Figure 8 shows that the control has been assumed by the far user, in fact the image is the web page that an user opens from internet, how we can see by the circle that emphasis the Microsoft Internet Explorer, performing the remote session by a general purpose web browser, and figure 9 confirms that status.

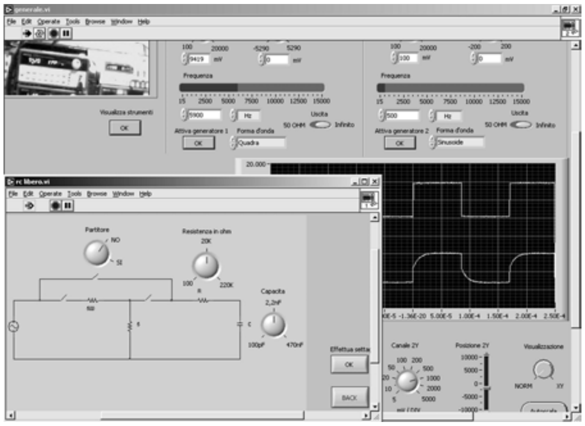

Fig. 6. Choice of the RC circuit configuration.

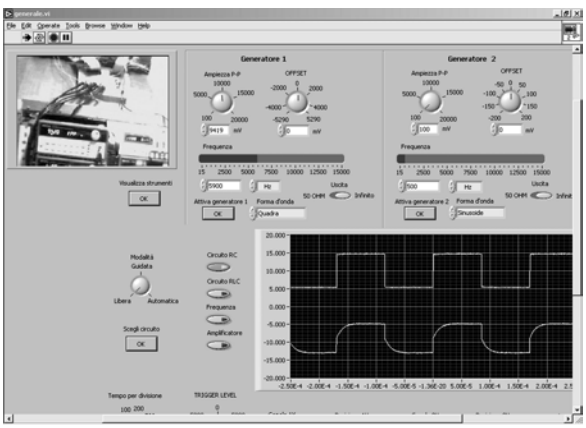

Fig. 7. Image from the webcam.

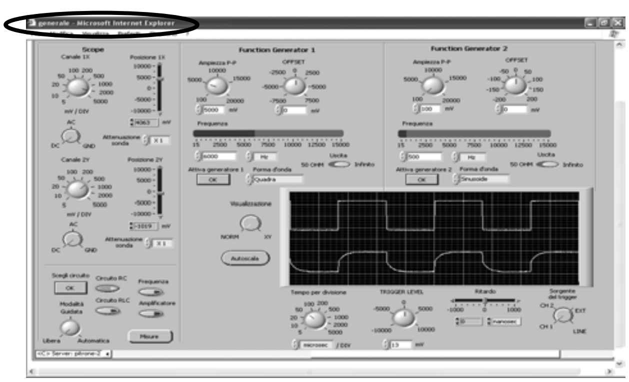

Fig 8. The far user controls the system by using a web browser.

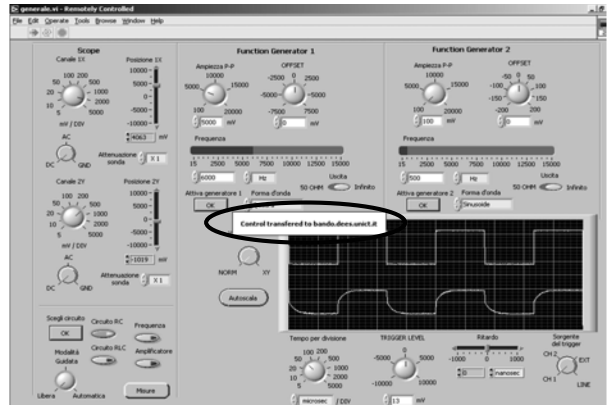

Fig 9. The server transfers control to the far user

V. CONCLUSION

Future development of the educational tool will include the possibility of a multi-users operation. Moreover, enhancing the “presence feeling” seems to be very important for far users, therefore a web camera located in the lab will give an overview of the system adopted for carrying out the experiment. In this way, the distance-learning user will have the plain feeling to be in the lab, carrying out the chosen experiment by using the real instruments. An attempt has been made to introduce such additional device, as shown in Figures 6 and 7; however, a better coordination with the implemented software is needed for the optimization of the transmission.

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